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ON THE

PHYSIOLOGICAL USES

OF THE

GANGLIONIC NERVOUS SYSTEM.

BY

JAMES GEORGE DAVEY, M.D., F.R.A.S.,

ETC., ETC.,

LATELY MEDICAL SUPERINTENDENT OF THE COUNTY OF MIDDLESEX LUNATIC ASYLUMS
AT HANWELL AND COLNEY HATCH (FEM. DEP.); AND FORMERLY OF THE
CIVIL (MEDICAL) SERVICE OF CEYLON (E. I.);

AUTHOR OF

"THE NATURE AND PROXIMATE CAUSE OF INSANITY,"

ETC., ETC.

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THE GANGLIONIC NERVOUS SYSTEM,

ITS STRUCTURE, FUNCTIONS, AND DISEASES;

BY

JAMES GEORGE DAVEY, M.D., &c., &c.

ADVERTISEMENT.

THE contents of the following pages were read, in *May* last, before the MEDICAL SOCIETY OF LONDON, and subsequently to the BATH AND BRISTOL MEDICAL AND SURGICAL ASSOCIATION. The "*paper*" is a mere abstract of a series of articles, entitled "THE PHYSIOLOGY AND PATHOLOGY OF THE GANGLIONIC NERVOUS SYSTEM," which were commenced in the columns of the "*Lancet*" for 1849 and 1850; but, for certain reasons, were never completed in that periodical. However, the whole of that published (in the "*Lancet*") was deemed of sufficient value by the Editor of "BRAITHWAITE'S RETROSPECT OF MEDICINE" (*see vol. xxii.*), to justify him not only in appropriating so many as sixteen of his closely printed octavo pages to its re-appearance, but he (BRAITHWAITE), moreover, considered the same as a "*desideratum*," and "*well worthy*"—"from its novelty and originality"—"*of attentive perusal.*" The attention which the late notice of the "*paper*" in the "*Lancet*" and "*Provincial Association Journal*" excited, has been *one* of the causes of its publication in this present form.

J. G. D.

Northwoods, Bristol, 1853.

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IF Gentlemen will be at the trouble to look to the most modern works on physiology; those, for instance, of WAGNER, of MULLER, of MAYO, of CARPENTER, and of TODD and BOWMAN, for information relative to the ganglionic nervous system, they will not find very much to satisfy their inquiries. The student will quickly perceive that concerning no subject in the whole domain of medical science, is there more ambiguity or contradictory evidence. Amid the diversity of opinions expressed, it will be difficult for him to arrive at any satisfactory conclusion. Like the old anatomists, with Haller at their head, he will *now* view the sympathetic nerve as a cerebral nerve; and *th en*, uncertain of his position, rank himself with Petit, who called it a spinal nerve.

Wagner insists on it that the ganglionic nerve is a *cerebro-spinal nerve*, that is to say, it is derived equally from the brain and spinal cord; Drs. Todd and Bowman very evidently favour the position of Wagner.

In the year 1836, I published a paper in the “Lancet” concerning the “*ganglionic nervous system* ;” and about two years anterior to this date, I conceived the idea of the entire independence of this system of nerves. From then until now, I have thought much of the matter ; and have, from time to time, written in the periodicals of the day concerning it. My physiological views are, to some extent, already before the medical profession ; they are contained in a series of papers in the “Lancet” for 1849 and 1850. It is my intention on this occasion to present to the Society a *résumé* of the principal facts and arguments collected and employed by me, as contained in the said papers ; and designed to prove that the “*ganglionic nervous system*,” with the SOLAR GANGLION for its central organ, not only exists altogether independently of the brain and spinal cord ; but, what is more, that the *brain* and *spinal cord*, in connexion with all the viscera, and the whole organism, derive their very existence and vital integrity from the same *solar ganglion* and its dependencies.

To begin with the beginning. It is very well known that the sympathetic nerve is that part first formed in the *fœtus*, that that which has been usually considered as the first traces of the vertebræ at the sides of the spinal cord, is, in fact, the ganglia of the sympathetic nerve ; that these are fully formed while the brain appears still a pulpy mass ; and that their functions are as perfect at birth as at adult age, while the brain is slowly perfected. These several *facts* are of the first importance to my position, and very naturally precede all else ; I have mentioned them on undoubted authority : and this will be directly conceded by you when I mention the names of MULLER, AKERMANN, ROLANDO, BLUMENBACH, and GALL. The ganglia mentioned then may be said to be the source or origin of the *impetum faciens*

of Hippocrates—the *materia vitæ* of Hunter—the *nisus formativus* of Blumenbach—or of the “*irritability*,” the *motions without force*, of the celebrated HALLER—and so on.

What sometimes happens during the *intra-uterine* life of the fœtus? “Human monsters,” says Blumenbach, “are not unfrequently met with who strongly resemble the form of brutes; and it is because,” he adds, “the ‘*nisus formativus*,’ or to speak more practically, the *ganglia of the sympathetic nerve*, having been disturbed and obstructed from some cause or the other, could not reach the highest pitch of the human form; but rested at a lower point, and produced a bestial shape.” The records of embryology furnish us with many important facts, bearing on physiology and pathology, but none more so than those connected with the creation and birth of the two monstrosities mentioned by Dr. Marshall Hall and Mr. Lawrence. In the first alluded to, there existed neither brain nor spinal cord; and in the second, the cerebral mass was alone wanting. I would beg you to bear in mind that the absence of both the *brain* and *spinal cord*, did not, in any way, affect the creation, growth, and maturity of that portion of the organism which remained. In the words of Dr. M. Hall, “the child” (such as it was) “was perfectly developed,” the *circulation*, *nutrition*, and *secretion*, had been duly performed WITHOUT a cerebro-spinal system. In Mr. Lawrence’s case of acephalous monstrosity, we learn that not only were all the excito-motory functions performed, and that the child gave evidences of pain, and “at first moved very briskly, and that the sphincters performed their office;” but, what is a very material point, and bears closely, and with much importance, on the question at issue, “the child’s *breathing* and *temperature* were natural,” and it moreover *discharged urine and fæces*. Now, in both the cases here cited, we have abundant

proof, of not only the entirety of the ganglionic nervous structure, but of its perfect independence of the cerebro-spinal system. We are assured thereby, not only of the capability of the organic nerves to sustain the intra-uterine life of the brainless and marrowless foetus; but of their power, alone and unaided, to develope and mature the organism itself. The facts narrated on the authority of Dr. Hall and Mr. Lawrence, demonstrate to us, that although *monstrosities* may and do exist without either a brain or a spinal cord—they cannot be either created or sustained without a *solar ganglion*, regarded as the root or *centre* of the said ganglionic, organic, or sympathetic nervous system. I quite agree with Dr. M. Hall, that the *intra-uterine* life of such monstrosities may be quite perfect, although there may be neither brain nor spinal marrow, *yet* that the child *dies* sooner or later after its birth; but I cannot quite assent to the cause of death urged by this gentleman. The true spinal or excitomotory functions are not so *directly* necessary to *life* as he would have us to believe; the fact is this—the amyencephalous monster of Dr. Hall ceased to exist because it could not “*breathe*,” because its direct relationship to the external world had not been provided for. The child was adapted only to an intra-uterine life; and not capable, therefore, of appropriating the materials of the external world to the requirements of its organism. In a word, the respiratory muscles were in a state of paralysis from the want of motor nerves; or, if not on this account, from the absence of the medulla spinalis. The circulation of blood surcharged with *carbon* would necessarily poison the animal tissues—precisely as takes place in all ordinary cases of death from the inhalation of carbonic acid, or of any other irrespirable gas. I may very properly add here, that in the foregoing remarks are found a most conclusive and satisfactory denial of

that “*experience*,” to quote the expression of Dr. Rogét—which “shows that when the influence of the brain and spinal marrow is intercepted, although the afflux of the blood may for a time continue, yet the secretion ceases, and all the functions dependent upon secretion, such as digestion, cease also ;” and not less of the very similar doctrine propounded by Dr. Marshall Hall, who, in his affection for the cerebro-spinal functions, teaches us that because *idiots* have small brains, and are short lived, therefore “the animal functions cannot go on permanently, independent of the brain.” It would be, gentlemen, an insult to your understandings to detain you with any argument to prove, what is so well known and appreciated, viz., that the imperfect development of the brain of the idiot is regarded only as an indication of the mal-organized condition of the entire nervous organism, including the *spinal* and *ganglionic*, not less than the *cerebral*. The *idiot* is nothing more or less than an immature specimen of the genus *homo*, and his existence is therefore less protracted. It is concluded, then, if the ganglionic system be deemed either necessary or competent to preside over the vital actions indispensable to the perfect development of the amy-encephalous monstrosity recorded by Dr. M. Hall—if the secretion, nutrition, circulation, &c., as carried on in it, in virtue of the said ganglionic system, are sufficient for its growth and maturity, and for the perfectibility of its several organs, as the liver, spleen, heart, &c., and the consequent exercise of their functions ; we cannot, by any possibility, doubt its power to preside over the vital actions necessary to the entire fœtus. If the ganglionic nervous system be sufficient to develop and mature a liver, a heart, and a spleen, and to excite them to the exercise of their appropriate functions in the animal economy,

there is no reason why it should not do the same for a brain and spinal marrow.

What is an accident to the *fœtus* is a design among the lowest class of animals. The exception in the former is the rule in the latter ; thus the brainless and marrowless monster is, organically speaking, on a par with the common *medusa*, or with the mere zoophytes generally ; and as for the acephalous being, described by Mr. Lawrence, it is, organically speaking, on a par with the moluscous animals, or more properly, perhaps, with the annelida. Among the first named, viz., the *medusariæ*, every vital action is described as conducted on the smallest scale, and by the least refined methods, and with the strictest economy of means ; its apparatus being the simplest, the agents employed the fewest possible, and its various operations being carried on in one and the same place. All of this class, the lowest appertaining to animal existence, are, like Dr. M. Hall's case of monstrosity, in the possession, *only*, of a ganglionic nervous system. As to the second, viz., the *molusca* or *annelida*, certain relations are very evidently exhibited to the surrounding media, and in these the external senses and voluntary motion gradually make their appearance, the organic apparatus necessary to the exercise of these functions being superadded. I may remark, by way of completion to the argument, that all of this latter class of animals are, like Mr. Lawrence's case of monstrosity, in the possession, not only of a ganglionic nervous system, but of a *spinal*. I would here impress on your minds the fact, that in the lower classes of animals above-named, the strictly vital functions are not less completely performed than the same in man ; although, unlike these, *he* enjoys a cerebro-spinal organism. Secretion, circulation, digestion, &c., are as

elaborately and efficiently executed in the *polypus* and *oyster* as in man ; and the greater simplicity of their breathing apparatus it is which modifies so considerably their relationship to the atmospherical influences about us.

It may be thought that I have already said sufficient to assure you of the truth of my physiological position ; or if not so, that further demonstration of the facts assumed by me cannot be forthcoming—but it happens in this instance, as in all others, when our aim is *truth*, and only TRUTH, that its evidence is so manifold and accumulative on an investigation, that the difficulty is not where to find the means of demonstration, but where *not* to find them. My object, however, is, in this paper, to be as *brief* as is compatible with the *practical* development of my views and opinions on the important subject which now engages our attention.

As I have already drawn my illustrations from a kind of *facts* which either occur spontaneously, or exist normally in the animal kingdom ; I will now seek for others which, though dissimilar, are yet of equal importance, *i. e.*, those acquired or created—those having an abnormal origin and existence.

If I take an animal belonging to the higher species, *i. e.*, belonging to those, the organism of which is similar to that of man, and by an operation deprive it of both the brain and spinal cord, and yet leave the said animal in the possession of life, and in the full exercise of all those functions strictly called VITAL,—it must be conceded that the same must be not only independent of the cerebro-spinal system, but what is more, the immediate result of the integrity of the solar ganglion, and its dependencies. I obtained a *frog*, and having removed the posterior parietes of the lumbar spinal canal, I introduced a small probe into the wound, and slowly

passed it through the whole length of the spine towards the cranium; the contents of which, together with the cord itself, were entirely destroyed (the cerebro-spinal structure was, of course, annihilated). All sensation and motion, of necessity, ceased from that moment; and the animal appeared *dead*. This experiment was performed in 1845, and I made the following note at the time, viz., “It is *now* nearly *three hours* since this animal was operated on, and the heart is still to be seen, through the thoracic parietes, contracting as vigorously as in any other animal.” The following remark is appended: —“In the absence of the cerebro-spinal functions, the animal before me is in a condition precisely similar to the amyencephalous monster of Hall, or to the mere polypus.” The great value of the above fact, regarded as an anatomical demonstration of the physiological views here insisted on, will be, I doubt not, directly appreciated. Müller who, with a pertinacity deserving of a better cause, will insist on it that the brain and spinal marrow must be regarded as the principal source of the nervous (vital) influence—nevertheless, informs his readers that, “in *fishes*, the contractions of the heart continue for the space of half a day after the destruction of the brain and spinal cord.” Now, Gentlemen, I am quite aware that it may be said, in reference to the above case of the frog, and not less to those of the “*fishes*” of Müller, that the effects observed resulted from a retained nervous influence; that on the performance of the *vivisections* the cardiac and other internal or organic nervous ganglia, being surcharged with motor power, were enabled to continue the vital phenomena for a given time—in the frog for some six or seven hours, and in the “*fishes*” for “half a day;” but this position could hardly be sustained. I would remind my hearers that *Rédi* (the Italian

anatomist) removed the brain of a frog, and that the animal lived “*six complete months*” after the operation; and that Sir B. Brodie removed the spinal cord without, in any way, affecting the strictly vital or “*organic*” actions in those parts subordinate to it. The bare idea of referring the issue of the experiments of Rédi and Brodie *to a retained nervous influence* is scarcely possible. I may add, in reference to the frogs and fish experimented on, that the peculiarity of their respiratory function renders them, in every way, eligible as a means of demonstrating the relative offices or qualities of the several nervous centres, viz., the *brain*, the *spinal cord*, and the *solar ganglion*; in other animals, higher in the scale of being, the destruction of the cerebrum and medulla spinalis would be directly fatal, unless the respiration was supported by artificial means. In mammals the respiration is, *as a general rule*, a mixed function, *i. e.*, one partly *vital* and partly *volitional*; a fact well known, and easily accounted for by the anatomist.

If the preceding facts and experiments be transposed—if the cerebro-spinal system be left intact, and the *solar ganglion* be brought within the reach of physical injury, what follows? All evidences of life cease from that moment—consciousness, volition, sensation, motion—secretion, digestion, respiration, circulation, sanguification—*calorification*—all are extinct. The brain, the cord, and all parts of the organism, which in health subserve the same, the viscera of the chest, abdomen, and pelvis fail their wondrous offices. The heart, lungs, stomach, liver, intestines together cease their aids in this wonderful machine in man and animals; and all is then, for ever, over. The first and great *mainspring of life*, *i. e.*, the SOLAR GANGLION, has lost its energies, and all the instruments wherewith it worked its destiny, and preserved its relations to the external world, are

therefore *dead* : and but waiting the operation of those eternal laws to which the physical world, in all its varieties, is made subordinate.

The observations already made derive no inconsiderable confirmation from the ordinary phenomena of disease. A visit to the wards of any lunatic hospital will give one the opportunity of witnessing many cases in which not only the brain but the spinal cord, have become so altered from their natural state, as to realise in the individuals affected, all the external signs of an incurable fatuity combined with a loss, more or less complete, of the powers of sensation and motion. The cessation of the cerebro-spinal functions, from long-standing disease of the brain and cord, will be apparent in the demented, enfeebled, and paralytic objects with which the wards of every establishment for the insane abound. However these same *objects* not unfrequently live several years without manifesting any of the ordinary signs of intelligence, or emotion, or passion—of either consciousness or volition—of either sensation or motion—else than what would appear to belong to some common *instinct* ; but during the period which intervenes between the accession of the disorder affecting the brain and spinal cord, and their decease, such patients are enabled to continue all the strictly vital functions; the respired air is decarbonised, and the blood is circulated. The digestive organs fail not in the performance of their functions; secretion, absorption, and nutrition, proceed in their accustomed course; in a word, the *solar ganglion* has not yet ceased to elaborate and to dispose of its peculiar stimulus to whatever portion of the animal organism is sufficiently intact to receive and appropriate the same. Though the *animal* functions have hardly less than ceased—the vital or organic remain: and precisely the

same thing obtains during sound *sleep*. Both disease, *i. e.*, in the sense just considered, and the phenomena of *sleep* are, in themselves, beautifully illustrative of the independence of the ganglionic nervous system; and both of these indicate plainly enough the natural line of demarcation between it and the cerebro-spinal,—or, what is the same thing, between the *animal* and *organic* functions.

It is now many years since that Sir B. Brodie, in order to test the sources of *nutrition*, *growth*, and the reproduction of lost parts, performed various experiments on animals; these had reference principally to the cerebro-spinal nerves, and their influence on the important vital acts named. This distinguished physiologist and surgeon proved exactly that contended for by Magendie and Reid, viz., that, provided the division of the nerves of the par-vagus was made in such a manner as not to affect respiration and the free oxygenation of the blood, the digestive function *i. e.*, “*nutrition*,” was unaffected thereby. He proved also that the reparation of injuries, both of the soft parts and of the bones (including fractures), was effected without the aid of a cerebro-spinal influence. Frogs, guinea-pigs, cats, and dogs, were the subjects of his experiments, and in each of these, either the spinal cord was destroyed, or portions of the crural and sciatic nerves removed; and on wounds and fractures being made in the extremities so deprived of nervous influence, the same were found to suppurate, heal, and unite, not less readily and completely, as under all ordinary circumstances. It does not, however, appear that Sir B. Brodie, or any one of the many commentators on his experiments, had any idea whatsoever that the valuable facts I have mentioned, did more than establish a *negative*; neither himself nor his contemporaries have even suggested, what I conceive to be the inevitable

sequence of the same facts, viz., that the *cat* digested its hearty meal as well *without* “the nerves of the eighth pair,” as with them, because only the solar ganglion and its dependencies were unaffected, left free to continue their normal uses in the animal economy; precisely as they were in the monstrosities of Hall and Lawrence, and precisely as they were (are) in the medusa, and in the helpless frog and “*fishes*” (in which the brain and spinal cord were both destroyed), and precisely as they were in him suffering from dementia and general paralysis: and also in one closely folded in the embrace of *Morpheus*. To continue,—that the frogs, guinea-pigs, and dogs, recovered from their wounds and fractures as well *without* their crural and sciatic nerves as with them, because only the solar ganglion and its dependencies were unaffected, *i. e.*, left free to continue their normal uses in the animal economy; precisely as they were in the several instances just recited.

The limits of this paper necessarily cause me to be very brief in my observations, or I may venture in treating of the subject of *animal heat*, regarding it as a specific function of the *solar ganglion*, to show to you how very unsatisfactory are the views and opinions up to this time advocated concerning it. I must then content myself by merely stating that “*animal heat*” is plainly *not* the product of any *chemical change* taking place, either in the lungs or in the discerning vessels; nor can it be said to arise out of the different capacities for *caloric* of the several fluid secretions of the body, and their source, viz., the *blood*, nor to depend “on the moistening of the organic structures by their several fluids,” which has been affirmed. I feel it necessary to add, that the contradictory results of experiments made to demonstrate the influence of the *cerebro-spinal system* on the generation of animal heat, must convince any impartial inquirer that this portion of the nervous organism has nothing

whatever to do with the same. In a paper "*On the Physiology and Pathology of the Ganglionic System*," which appears in the "*Lancet*" for October, 1842, I have written, "Do we doubt that the solar ganglion, or plexus, is the principal, nay, the only source of '*animal heat*?'" I would beg you to bear in mind, in reflecting on this matter, that the presence or otherwise of the brain and spinal cord in the *fœtus* affects not the *animal heat*; the acephalous monstrosity maintains its temperature as long as it may live, and so does the decapitated animal, in which also the spinal cord is destroyed. We know, of a surety, that in all such cases the solar ganglion is, however, still in the exercise of its normal functions, and we may know too, if we will be at the trouble to investigate this question, that if, from any cause, the normal function of this same important nervous centre be interfered with, or interrupted in any way, that the *animal heat* will directly fail. A comparatively gentle blow on the epigastrium will produce a very sensible diminution of the temperature of the body in man and in animals, and one less gentle, will cause an individual to fall into a cold perspiration, as it is called. A blow or injury which may be borne with comparative impunity elsewhere, if it take effect on the epigastrium, will not, unfrequently, cause the animal heat to sink so low as not to be re-kindled. It is true, the diminution or suspension of animal heat from physical violence or injury taking effect on the epigastrium over the solar ganglion, is attended with a sensible effect on the vital functions generally; but this fact, instead of weakening my position, does but confirm it. Dr. Alison and M. Chaussat tell us, that those injuries to the nervous system which lower the temperature of animals are the same which manifestly diminish the processes

of secretion and nutrition ; and the fact, in itself, must assure us that the solar plexus, or ganglion, is the *source* from whence the *animal heat*, equally with the “processes of secretion and nutrition,” is derived. I would remind my hearers, that in the serpent tribe the *animal heat* exists in a very small quantity, the temperature is very low indeed, and those vital acts, such as the circulation, respiration, digestion, &c., upon which *secretion* and *nutrition* depend, are alike feeble and inactive. On the other hand, it is well-known, that the animal heat is invariably increased after a good meal, and that the vital acts named are *then* the very reverse of *feeble* and *inactive*. It is important to know that Dr. John Davy and Müller have shown by experiments that the further we go from the *epigastrium*, “*the centre of the body*,” the more does the animal heat decline. The former says that the temperature of the *rectum* even is higher than that of the *brain* ; and I have somewhere read that the large intestines retain their temperature and vitality, in cases of suspended animation from hanging, or drowning, or hæmorrhage, and so on, very much longer than even the brain ; and this is, of course, what may be expected and what should be.

Another specific function belonging to the organic nerves is “*instinct*.” In Blumenbach’s Physiology there occurs these two passages, viz.—1st. “The ganglionic nervous system within the abdomen and chest is fully formed, whilst the *brain* appears still a pulpy mass.” 2nd. “These ganglia and their nerves would hardly be formed before the brain and spinal marrow, but for the sake of the organs which they supply, and the functions of which (with the exception of the genitals) are as perfect at birth as at adult life, while the mind and brain are slowly perfected.” Now, although these preceding remarks

are intended by their author to show that the organs presiding over the vital or *organic* functions—as the heart, lungs, liver, alimentary canal, and so on—enjoy an existence long anterior to the cerebro-spinal system, which performs the *animal* functions, *i.e.*, those which connect man and animals more directly with the external world—yet did he (*Blumenbach*) fail to recognise the facts here quoted as evidence of my position; viz., that *instinct* is, like *animal heat*, a specific function of the *solar ganglion*, regarded as the root or centre of the organic, ganglionic, or sympathetic nervous system. Instinct, not less than the “*organic functions*,” so named by *Bichat* and *Blumenbach*, is perfect at BIRTH; and no sooner does extra-uterine life really commence than the child performs instinctive acts. What is true of the genus *homo*, is true also of the mammals, quadrupeds, birds, reptiles, and fishes, the insectora, the annelida, and so through the whole “chain of being,” from man to the mere zoophyte. The presence or absence of the brain and spinal cord affect not the *instinct*; this is a property of the human organism as inseparable from it as the same organism is from the ganglia of the sympathetic nerve—which creates, and, what is more, nourishes and sustains the same. Instinct is nothing more or less than a *vital* act, and like secretion, nutrition, exhalation, and absorption, is never seen but in connexion with the sympathetic nerve; and like secretion, &c., may, and does, exist independently of a *brain* and *spinal cord*; and hence, the manifestation of this quality (instinct) in the amyencephalous monstrosity of Dr. M. Hall, and in the common *medusa*.

The solar ganglion and its dependencies are perfect the very first hour of animal life, and so are the instinctive faculties in man, and in all the inferior animals. On the

the other hand, the brain and spinal cord are very far from *perfect* at birth, and the maturity of their faculties or functions may not be looked for until after long years of tuition and experience.

To conclude—Müller has written much about an “*organising principle*,” a “*creative force*.” Admitting, for argument sake, the existence of such a quality, it would seem to be *first* directed towards the development of a central organ or organs (the solar ganglion or the ganglia of the sympathetic), predestined not only to give *life* but *form* to the whole animal organism—and which, moreover, it creates; predestined to give to the “*organic creative powers*,” as they are termed, their peculiar force and direction; which together determine the essential parts of the future animal, and its rank and position in the scale of infinite being; assign to the same its genus, or species, or variety—and give it, in short, “*a local habitation and a name*”—

“ Human, angel, man—

Beast, bird, fish, or insect—what no eye can see,

No glass can reach, from infinite to thee;

From thee to nothing.”—(POPE.)

Predestined, lastly, to hold a precisely similar relation to the otherwise insensible and inert frame—to the otherwise dull and unmoving organism, as the “vital fire” to the animated statue of *Prometheus*.

Such, Mr. President and Gentlemen, is what may be looked on as the mere outline or EPITOME of my views relative to the “*Physiological Uses of the Ganglionic Nervous System*.”